The Role of Artificial Intelligence in the Academic Work of Preservice Teachers

Haley Olson, Emporia State University
Haley Olson is an assistant professor in The Teachers College at Emporia State University in Emporia, KS.
Emily Cline, Emporia State University
Emily Cline is an assistant professor in The Teachers College at Emporia State University-Kansas City in Olathe, KS.

Introduction

Integrating artificial intelligence (AI) into higher education has rapidly transformed pedagogical practices across disciplines, including teacher education (Wang et al., 2024). AI offers new opportunities for enhancing pre-service teacher education methods courses, which are critical in preparing future educators for the complexities of contemporary classrooms (Mosher, 2024; Dieker et al., 2014). By employing AI technologies—such as intelligent tutoring systems, automated feedback tools, virtual simulations, and adaptive learning platforms—teacher educators can create more personalized, data-informed, and interactive learning experiences (Attali & Burstein, 2006; Cotos, 2023; du Plooy, 2024; VanLehn, 2011). These innovations are poised to improve instructional design, foster reflective practice, and support the development of essential teaching competencies among pre-service teachers (Dieker et al., 2014; Nichol et al., 2025).

Given this rapid transformation, it is critical to investigate how teacher preparation programs, particularly methods courses that bridge theory and practice, are integrating AI tools, navigating their pedagogical implications, and addressing both the challenges and opportunities that accompany their adoption in educator training.

The application of AI in pre-service teacher education methods courses carries significant implications for the preparation of future educators. AI technologies can enhance instructional efficacy by providing personalized and adaptive learning experiences that enable pre-service teachers to engage with content at a suitable pace and receive immediate, data-driven feedback (Chen et al., 2020; Zawacki-Richter et al., 2019). This tailored support can promote a deeper understanding of pedagogical concepts and effective classroom strategies (Chen et al., 2020; Holmes et al., 2022). Furthermore, AI-powered simulations and virtual teaching environments present valuable opportunities for experiential learning and reflective practice, circumventing the constraints of traditional field placements (Dieker et al., 2014; Cook et al., 2022; Howard et al., 2023).

Nevertheless, the integration of AI also raises critical concerns related to data privacy, equity of access, and the potential depersonalization of teacher preparation. The U.S. Department of Education emphasizes that AI-driven systems often require “access to detailed data beyond conventional student records,” thereby heightening privacy, security, and governance risks (U.S. Dept. of Education, 2022). It further cautions that when instructional decisions are automated at

scale, “unintended consequences could widen achievement gaps” (U.S. Dept. of Education, 2022). Moreover, equity concerns arise when non-representative datasets shape AI algorithms that may “act unfairly in how they detect patterns or automate decisions” (U.S. Dept. of Education, 2022). Empirically, a national survey found that fewer than half of districts had robust policies for how student data are retained, encrypted or accessed — even as AI use grows (CoSN, 2025). Consequently, educator preparation programs must carefully navigate this complex landscape, balancing the advantages of technological innovation with thoughtful consideration of ethical, practical, and pedagogical challenges.

To that end, we conducted a study to examine the use of AI by pre-service teachers in their education methods courses and the impact this use can have on the higher education landscape, as well as on initial teacher preparation coursework. Grounded in Flavell’s (1987, 1992) theory of metacognition, the study explores how pre-service teachers’ awareness of their own learning processes influences the ways they engage with AI tools. Within this framework, AI use is viewed not merely as a technological skill, but as a reflection of students’ personal variable*s*, or their beliefs and knowledge about themselves as learners, task variables, which is their understanding of the cognitive and procedural demands of a given assignment, and strategy variables, or their ability to plan, monitor, and adjust their methods to achieve learning goals (Flavell et al., 1993).

The study aims to understand how faculty can support pre-service teachers in developing these metacognitive capacities by designing strategically planned assignments that encourage reflective AI use, foster goal setting, and reinforce academic integrity. Additionally, we sought to determine whether there was a correlation between students’ AI use in their methods courses and their use of AI in everyday life, as such a relationship may illuminate how metacognitive awareness extends beyond academic contexts. A self-reported survey, the *EDUCAUSE AI Landscape Study Survey Instrument* (Robert, 2024), was completed by pre-service teachers in their junior or senior year, when they were enrolled in elementary or secondary education methods courses.

The study focused on answering two research questions:

1. To what extent and in what ways do pre-service teachers use AI in their education methods courses, and how does this relate to their metacognitive awareness and use of AI in everyday life?

2. How do pre-service teachers perceive AI’s impact on their learning, task performance, and preparation for future teaching, and what instructional supports do they identify as most beneficial?

The results from the survey will provide an understanding of student perceptions about AI’s impact on their learning in education methods courses. The significance of the findings will serve to guide how teacher preparation programs respond and proactively create measures to support the student population and engage in effective AI utilization practices.

Theoretical Framework

This study is grounded in Flavell's (1987, 1992) theory of metacognition, which describes how learners monitor, evaluate, and regulate their thinking processes through three interrelated domains of knowledge: personal, task, and strategy variables. Within the context of AI use, these domains provide a lens for examining how pre-service teachers make decisions about when and how to use AI tools in their education methods courses.

- Personal metacognitive knowledge involves understanding one's strengths, limitations, and beliefs as a learner, shaping how pre-service teachers determine whether AI aligns with their learning preferences or ethical boundaries.
- Task metacognitive knowledge pertains to awareness of assignment requirements and the cognitive demands of teaching tasks, guiding how students judge when AI support is appropriate or excessive.
- Strategic metacognitive knowledge involves planning, monitoring, and evaluating the effectiveness of chosen strategies—in this case, how pre-service teachers integrate AI into their coursework and assess its value in promoting deeper learning and professional growth.

Extending Flavell's framework to the digital era, metacognition here also encompasses technological self-regulation: the ability to critically evaluate the role of AI in one's learning, maintain academic integrity, and apply reflective decision-making that bridges classroom and everyday use.

Literature Review

Introduction to AI in Higher Education

AI is increasingly recognized as a transformative force in higher education. Defined broadly, AI encompasses a range of technologies, including machine learning, natural language processing, and computer vision, that simulate human cognitive functions and support decision-making processes. As Hwang (2023) emphasizes, the ability to use AI is now regarded as an essential competency for digital literacy, making AI proficiency an integral component of 21st-century higher education. Within universities, AI is reshaping core institutional practices by enabling personalized learning pathways, predictive analytics for student success, and adaptive feedback systems that enhance instructional quality (Zawacki-Richter et al., 2019; Chen et al., 2020; Holmes et al., 2022). The rapid integration of AI into assessment, advising, and academic support infrastructures has led many scholars to view AI as a defining feature of the evolving digital university (Ng, 2021; U.S. Department of Education, 2023).

The adoption of new technologies has long shaped teaching and learning in higher education, from overhead projectors to interactive whiteboards, and AI represents the latest stage in this trajectory. According to the U.S. Department of Education (2023), AI holds significant promise for improving teaching and learning experiences by assisting with grammar correction, idea generation, automated grading, and the development of customized learning resources. At the same time, its use introduces pressing challenges, including concerns about plagiarism, privacy, security, and inaccuracies in AI-generated output. These opportunities and risks are particularly salient for pre-service teacher education, where students simultaneously experience AI as

learners within higher-education contexts and as emerging professionals preparing to implement such tools in their own future classrooms.

Trends in AI Adoption in Higher Education

The adoption of AI in higher education has already demonstrated utility in addressing institutional challenges such as enrollment and retention. Barrett et al. (2019) noted that conversational interfaces, textbots, and data analytics have been used successfully to combat low enrollment and improve student retention. Within the classroom, however, tools such as ChatGPT and other AI-based assistants have generated significant debate, raising questions about their appropriate use in academic settings (Zhang et al., 2023).

Although there is a growing body of research on AI in education, Zhang et al. (2023) highlighted that most studies have focused on in-service teachers, leaving pre-service teacher education comparatively underexplored. This gap is notable, as AI's impact on pre-service teachers extends beyond academic performance to influence professional preparation and identity formation. Early findings suggest potential benefits, such as improved productivity and creativity in designing instructional materials, lesson plans, and assessments (Black et al., 2024). However, AI also presents limitations, as large language models (LLMs) are prone to factual inaccuracies and logical inconsistencies, often referred to as "hallucinations" (Scarfe et al., 2024). This dual nature of AI provides a rationale for closely examining its impact on pre-service teachers, who must learn to harness its benefits while navigating its limitations. As higher education institutions increasingly integrate AI into coursework, advising, and assessment (Zawacki-Richter et al., 2019; U.S. Department of Education, 2023), understanding how these tools function within teacher preparation programs becomes essential. Examining specific applications of AI in teacher education offers insight into how emerging technologies can both enhance and complicate the development of instructional expertise and professional judgment among future educators.

AI Applications in Teacher Education

One of AI's most prominent applications in teacher education lies in its ability to personalize learning. Adaptive systems can adjust instructional content based on student performance, thereby increasing engagement and supporting student retention. Such systems hold promise for enhancing learning outcomes by tailoring instruction to individual needs.

AI-driven tutoring and support tools, including chatbots and virtual assistants, provide accessible, on-demand learning support. Studies of intelligent tutoring systems and custom educational chatbots show gains in learning efficiency and targeted support, and experiments with virtual assistants indicate reductions in cognitive load that free learners to focus on more complex tasks (Kulik, 2016; Ma et al., 2014; Lademann et al., 2025; Brachten et al., 2020).

Another significant area of AI application is assessment. Automated grading and real-time feedback tools can reduce instructor workload while offering students timely insights into progress (Attali & Burstein, 2006; Deepshikha & Arora, 2025; Tan et al., 2025). However, ensuring fairness, accuracy, and transparency remains a central concern in both formative and

summative assessments, with recent federal guidance and empirical studies underscoring risks around bias, explainability, and student trust in AI-supported grading (U.S. Department of Education, 2023; Jones-Jang et al., 2025; Mpolomoka & Charalambous, 2025).
In addition to assessment, lesson planning has emerged as an area where AI can streamline time-intensive tasks. Powell and Courchesne (2024) demonstrated that ChatGPT could generate a complete 5E lesson plan aligned to specified standards at the elementary science level. While the AI-generated plan provided high-quality, standards-aligned activities, it also contained missing details and inaccuracies related to scientific inquiry. Furthermore, aspects of the lesson plan exceeded the cognitive level appropriate for first-grade students. These findings suggest that AI can be a valuable support tool in lesson planning, but preservice teachers must critically evaluate AI output to ensure instructional appropriateness.

Perceptions and Acceptance of AI Among Students

Student perceptions play a critical role in determining the effectiveness of AI tools in teacher education. While many students acknowledge potential benefits for learning efficiency, they also report concerns about overreliance, data privacy, and ethical use (Chan, 2023; U.S. Department of Education, 2023). Research in higher education consistently finds that student acceptance is shaped by institutional conditions, particularly the availability of clear policies, training, and support (EDUCAUSE, 2024; Jeilani & Abubakar, 2025). Programs that provide structured opportunities to engage with AI—and guidance on responsible, academically honest use—are more likely to foster positive attitudes and effective integration into learning processes, including among pre-service teachers (Bilbao Eraña et al., 2025; Gamlem et al., 2025; Sanusi et al., 2024).

Implications of AI for Future Teacher Education Courses

The integration of AI into teacher education has significant implications for course design and curriculum development. Black et al. (2024) proposed a framework of seven strategies for redesigning educator preparation programs (EPPs) to better prepare pre-service teachers for AI-enhanced learning environments. Key strategies include fostering a foundational understanding of AI, embedding AI literacy across coursework, aligning AI use with existing ISTE standards, and providing opportunities for students to engage directly with AI tools in their own learning. The authors emphasized that AI literacy should be systematically addressed across all EPP coursework rather than confined to isolated courses.

This shift requires moving beyond traditional curricula to embrace skills-based and personalized models of teacher preparation. By integrating AI into coursework, institutions can prepare future teachers not only to use AI tools effectively but also to critically evaluate their limitations, ethical implications, and pedagogical value.

The literature indicates that AI is poised to significantly reshape higher education, particularly in pre-service teacher preparation. AI applications such as personalized learning, tutoring, assessment, and lesson planning offer substantial benefits for both students and instructors, but these benefits are accompanied by challenges related to accuracy, ethics, and student perceptions. Research to date has focused primarily on in-service teachers, highlighting the need for more studies on pre-service teachers who are simultaneously developing professional skills

and digital competencies. Integrating AI literacy into educator preparation programs is essential to ensuring that future teachers can navigate the opportunities and risks of AI with critical insight. As higher education continues to adapt to rapidly evolving AI technologies, intentional curriculum redesign will be vital to preparing teachers for the classrooms of tomorrow.

Methods

Participants

The participants were 37 preservice teachers enrolled at a mid-sized public university in the Midwest United States. Participants represented three stages of progression within the elementary education program. These included: (a) *Block 2* elementary education majors (PK–6) at the main campus and two metropolitan distance sites—students one semester from student teaching; (b) *Block 1* elementary education majors (PK–6) at the same locations—students two semesters from student teaching; and (c) *Pre-Block* elementary education majors (PK–6) at the main campus and distance sites—students three or more semesters from student teaching. All participants were actively enrolled in elementary education methods courses at the time of survey completion.

Procedures

Following Institutional Review Board (IRB) approval, participants were recruited from upper-level education methods courses during the final weeks of the academic term. After receiving a study overview, participants provided informed consent through a secure Qualtrics form. Students who did not consent were automatically exited from the form, and their data were not recorded. Participation was voluntary and anonymous.

Data were collected using the *EDUCAUSE AI Landscape Study Survey Instrument* (Robert, 2024), a nationally recognized instrument developed to examine patterns of AI use, readiness, and perceptions among higher education students. The survey has demonstrated strong internal consistency and construct validity in previous large-scale implementations (Cronbach's α ranging from .82 to .91 across subscales; EDUCAUSE, 2024), supporting its reliability and appropriateness for use in higher-education contexts.

The survey consisted of 24 items measuring students' engagement with AI in both academic and non-academic contexts. Each item was rated on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Items were organized into three subscales reflecting the study's research aims: (a) Student AI Usage, (b) Student Readiness, Satisfaction, and Expectations, and (c) Student Perceptions and Attributes. The inclusion of self-reported daily AI use allowed for exploration of potential correlations between students' general technology engagement and their AI use in methods coursework.

Survey responses were automatically recorded in Qualtrics and exported into SPSS for analysis. Descriptive statistics summarized participant demographics and overall AI engagement levels, while correlational analyses examined relationships between AI use in academic and personal contexts, aligning directly with the study's research questions.

Data Analysis Procedures

Data from the Qualtrics survey were exported into SPSS version 29 for analysis. Prior to conducting inferential tests, data were screened for missing values, outliers, and normality to ensure accuracy and reliability. Descriptive statistics—including means, standard deviations, and frequency distributions—were calculated to summarize participant demographics and overall patterns of AI use. Internal consistency reliability for each survey subscale (Student AI Usage, Student Readiness, Satisfaction, and Expectations, and Student Perceptions and Attributes) was assessed using Cronbach's alpha, which demonstrated acceptable reliability levels ($\alpha > .80$).

To address Research Question 1, which examined how and to what extent pre-service teachers use AI in their education methods courses, frequency distributions and mean comparisons were analyzed across relevant items. To address Research Question 2, exploring perceived impacts of AI on learning and professional preparation, Pearson's correlation coefficients were used to assess relationships between AI use, perceptions of learning improvement, and self-reported daily AI engagement.

Additionally, open-ended responses were analyzed thematically to identify patterns related to student reflections on AI use, ethical concerns, and institutional support. These qualitative findings were used to contextualize the quantitative data, providing a richer understanding of pre-service teachers' experiences. Triangulation of data sources strengthened the validity of the study's findings and aligned with the metacognitive framework guiding the research.

Overall, the methods outlined above provided a structured approach for investigating pre-service teachers' engagement with AI in their education methods courses. The combination of validated survey data, correlational analysis, and thematic coding allowed for both quantitative and qualitative insights into patterns of AI use, perceptions of learning impact, and connections to broader metacognitive processes. The following section presents the results of these analyses, highlighting key findings related to the research questions.

Results

Survey data were collected through Qualtrics following participant consent. The *EDUCAUSE AI Landscape Study Survey Instrument* (Robert, 2024) was administered to gather quantitative and qualitative responses about preservice teachers' engagement with AI in both academic and everyday contexts.

Findings Related to Research Question 1: Patterns of AI Use

To address Research Question 1: To what extent and in what ways do preservice teachers use AI in their education methods courses, and how does this relate to their metacognitive awareness and use of AI in everyday life? - descriptive statistics and correlations were examined to explore usage trends and relationships between academic and personal AI use.

Out of 37 participants, 15 respondents (40%) indicated that they *never use AI academically*, and 12 respondents (32%) reported that they *never use AI in everyday life*. The frequency distribution

of AI use revealed a negatively skewed pattern: as the reported frequency of AI use per week increased, the number of respondents selecting those higher-use categories decreased. Table 1 and Figure 1 illustrate the distribution of AI use across academic and everyday contexts.

These results address Research Question 1, suggesting that while preservice teachers are aware of AI technologies, consistent application remains limited. Moreover, the strong correlation between AI use in daily life and academic work ($r(37) = .921$, $p < .001$) indicates that students' broader comfort with AI strongly predicts their academic adoption. This finding supports the study's metacognitive framework: familiarity and self-awareness regarding one's learning strategies appear to influence whether and how students integrate AI into coursework.

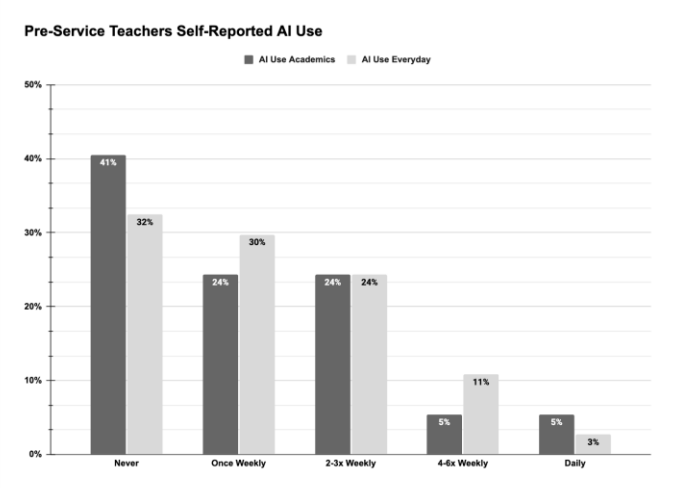
Table 1

Frequency of Reported AI Use in Academic and Everyday Contexts

	Pre-Service Teachers AI Use (N=37)	
	Academics	Everyday
Never	15	12
Occasionally	9	11
Monthly	9	9
Weekly	2	4
Daily	2	1

Figure 1

Distribution of AI Use Frequency Across Academic and Everyday Contexts



A Pearson correlation coefficient was calculated to determine the relationship between self-reported AI use for academic purposes and AI use in everyday life. A strong, positive correlation was found between the two variables, $r(37) = .921$, $p < .001$, indicating that students who use AI more frequently in their daily lives are also more likely to use AI in their coursework. This

finding aligns with the study's metacognitive framework, suggesting that students' awareness of their own learning habits and cognitive strategies influences how they apply AI tools across academic and personal domains. Table 2 presents the full correlation matrix.

Table 2

Correlation Between Academic and Everyday AI Use

	Academics		Everday Life		*r*
	M	SD	M	SD	
AI Use	2.22	1.109	2.11	1.173	.921***

***p<.001

These results indicate that while preservice teachers demonstrate limited overall AI use, those with higher self-awareness and familiarity with AI technologies in everyday contexts are more likely to transfer these strategies into academic settings.

Findings Related to Research Question 2: Student Perceptions and Institutional Support

To address Research Question 2, How do preservice teachers perceive AI's impact on their learning, task performance, and preparation for future teaching, and what instructional supports do they identify as most beneficial? - Likert-scale items and open-ended responses were analyzed to capture student perceptions and expectations of AI integration.

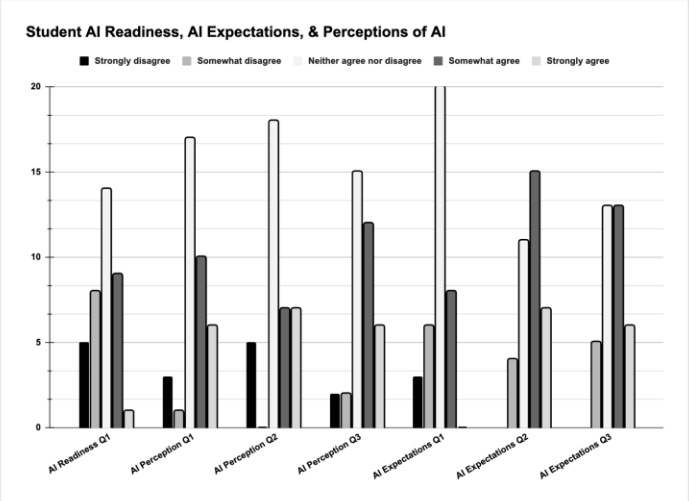
Participants responded to items grouped into three categories: *S*tudent Readiness to Use AI, Student Expectations for AI Integration in Coursework, and Student Perceptions of Student and Instructor Roles in AI Use. Across all subscales, students generally agreed that AI can enhance learning when used responsibly, though many expressed uncertainty about best practices and ethical boundaries.

Two survey items received particularly high mean ratings:

1. "Instructors should provide training on the effective use of AI tools in education methods courses."
2. "Instructors should involve students in the decision-making process regarding which AI tools are implemented for assignments."

Figure 3 includes descriptive statistics for all Likert-scale items within these categories.

Figure 3
Descriptive Statistics for Student Perception, Readiness, and Expectation Items



Collectively, these findings suggest that preservice teachers perceive AI as a promising educational tool but require structured guidance to use it effectively and ethically. This aligns with the metacognitive framework, as students recognize the need to monitor their understanding, regulate their approach to AI use, and seek strategic instruction from faculty to enhance cognitive and professional growth.

In summary, findings indicate that preservice teachers' AI use remains limited but shows a strong relationship between academic and everyday contexts. Students expressed positive attitudes toward AI's potential to enhance learning but emphasized the importance of instructor guidance, training, and ethical parameters. Together, these results address both research questions by illustrating how preservice teachers' metacognitive awareness and learning environments influence their engagement with AI technologies. The following section discusses these findings in relation to the existing literature and theoretical framework.

Discussion

Overview of Findings

This study examined how preservice teachers in higher education engage with AI tools in their education methods courses and how their perceptions and behaviors reflect elements of metacognitive awareness. Guided by Flavell's (1987, 1992) theory of metacognition, the findings demonstrate that preservice teachers' AI use is influenced by their self-awareness as learners, their understanding of instructional tasks, and their strategies for applying AI tools in academic and personal contexts.

Findings Related to Research Question 1: Patterns of AI Use

Results indicated that preservice teachers' use of AI in both academic and everyday contexts remains relatively limited. However, a strong positive correlation between every day and academic AI use suggests that general familiarity and comfort with AI tools strongly predict academic adoption. This pattern aligns with the *personal* and *strategy* components of Flavell's metacognitive model, as students appear to rely on their broader experiences with AI to guide decisions about when and how to use these technologies in coursework.

These findings are consistent with prior research indicating that students' existing digital literacy and confidence with technology influence their willingness to engage with AI for learning (Zawacki-Richter et al., 2019; Wang et al., 2024). In higher education, this suggests that metacognitive self-awareness—understanding one's capabilities, limitations, and preferences as a learner—plays a central role in determining AI adoption patterns. Programs that help preservice teachers reflect on their own learning processes and transfer effective AI strategies from everyday contexts to academic applications may enhance both engagement and learning outcomes.

Findings Related to Research Question 2: Perceptions of AI and Instructional Support

Student responses revealed positive but cautious perceptions of AI's role in teaching and learning. Participants agreed that AI can enhance efficiency and creativity, yet they emphasized the need for explicit instruction, ethical guidance, and opportunities for shared decision-making around AI integration. These findings correspond to the *task* and *strategy* elements of metacognition, which involve understanding the cognitive demands of a task and planning appropriate strategies for success (Flavell et al., 1993).

Like recent higher-education studies (Chan, 2023; Bilbao Eraña et al., 2025; EDUCAUSE, 2024), students' attitudes were most favorable when institutions provided structured support, transparent guidelines, and reflective opportunities. Within teacher education, this indicates that preservice teachers not only need to acquire AI competencies but must also develop the metacognitive capacity to evaluate when AI use aligns with ethical teaching practices and learning objectives. Intentional faculty scaffolding can help students critically appraise AI tools rather than using them unreflectively.

Implications for Practice

The results of this study highlight several implications for educator preparation programs seeking to prepare pre-service teachers for an AI-rich educational landscape. Students' calls for instructor-led training suggest that AI literacy must be embedded across teacher preparation curricula. Structured opportunities to experiment with AI in coursework can help normalize its responsible use while equipping students with transferable skills (U.S. Department of Education, 2023; Zhang et al., 2023). The findings underscore the importance of embedding metacognitive reflection and digital ethics into teacher-education curricula. When preservice teachers are encouraged to analyze how AI supports or hinders their learning, they develop professional habits of reflection that mirror effective classroom pedagogy. Institutions of higher education can

leverage this by designing assignments and discussions that explicitly prompt students to: identify their goals for using AI, evaluate the reliability and appropriateness of AI outputs, and regulate their own learning strategies accordingly.

Such pedagogical moves support the U.S. Department of Education's (2023) call for "human-centered AI integration" that enhances critical thinking and equity in higher education. Structured training, faculty mentorship, and ethical guidance can strengthen students' strategic metacognition and prepare them to incorporate AI thoughtfully in their future classrooms.

Based on the study's findings and theoretical grounding in metacognition, several actionable recommendations emerge for higher education institutions and teacher-education programs seeking to integrate AI responsibly and effectively:

1. Embed Metacognitive Reflection into Coursework: Faculty should design assignments that require students to reflect on their AI use considering Flavell's (1987, 1992) categories of metacognitive knowledge: personal, task, and strategy. Structured reflections can help students evaluate their reliance on AI, recognize conceptual gaps, and identify productive strategies for integrating AI into their professional practice.
2. Provide Explicit AI Literacy and Ethics Training: Institutions should develop targeted workshops or modules that address both the technical and ethical dimensions of AI use, including bias, data privacy, authorship, and academic integrity. Training should emphasize human-AI collaboration rather than automation of thinking.
3. Integrate AI into Existing Pedagogical Frameworks: Rather than positioning AI as a novelty, faculty should embed AI applications within existing methods-course structures (e.g., lesson planning, assessment design, or reflection activities) to model authentic, pedagogically sound use.
4. Assess AI Competencies as Part of Professional Readiness: Teacher-education programs can include AI literacy and metacognitive regulation as explicit components of professional standards or program outcomes. Doing so aligns with the U.S. Department of Education's (2023) emphasis on "human-centered AI" and prepares future educators to guide their own students responsibly in an AI-enhanced world.

These recommendations extend beyond immediate instructional practices, positioning AI integration as an opportunity to strengthen metacognitive awareness, ethical reasoning, and reflective pedagogy among preservice teachers. Through intentional design, higher education institutions can ensure that AI serves not as a shortcut to learning, but as a catalyst for deeper cognitive engagement and professional preparation.

Limitations

Although the study provides insight into preservice teachers' early experiences with AI, the small sample size and single-institution context limit generalizability. Future research should examine diverse teacher-education programs and longitudinally track how AI use evolves as preservice teachers transition into student-teaching and professional roles. Additional studies could explore metacognitive interventions, such as reflective journals or AI-based tutoring simulations, to assess how guided reflection influences both AI literacy and teaching competence.

Conclusion

This study contributes to the growing discourse on AI in higher education by examining preservice teachers' engagement with AI through a metacognitive lens. Grounded in Flavell's (1987, 1992) theory of metacognition, the findings reveal that preservice teachers' AI use—both in academic and personal contexts—is shaped by their self-awareness, task understanding, and strategic regulation of learning. Students' positive perceptions of AI's potential, coupled with their call for structured guidance and ethical training, underscore the critical role of faculty and institutions in shaping responsible, reflective AI integration within teacher education.

By connecting metacognitive theory to practical AI literacy, this study highlights a pivotal shift in how future educators must learn to think about their thinking while engaging with intelligent technologies. The results suggest that effective AI use is not merely technical proficiency but a cognitive and ethical process of reflection, evaluation, and adaptation. For higher education institutions, embedding metacognitive reflection, AI ethics, and digital pedagogy into teacher-preparation curricula can promote not only technological competence but also critical self-regulation and professional growth.

Future research should build on these findings by exploring longitudinal impacts of AI training across the teacher-preparation continuum and investigating how explicit metacognitive interventions influence both learning outcomes and ethical decision-making. As AI continues to evolve, preparing educators who can navigate this landscape with self-awareness, integrity, and pedagogical intentionality will remain essential to the mission of higher education.

References

Attali, Y., & Burstein, J. (2006). Automated essay scoring with e-rater® V.2. *Journal of Technology, Learning, and Assessment, 4*(3).

Barrett, N. E., Tigerstedt, C., & Fudge, D. L. (2019). Artificial intelligence and predictive modeling in higher education: New opportunities for enrollment management. *Journal of Enrollment Management, 23*(2), 45–60.

Bilbao Eraña, A., Pons Seguí, L., & Usabiaga Otegui, O. (2025). Fostering AI literacy in pre-service teachers: Impact of a training intervention. *Frontiers in Education*. https://doi.org/10.3389/feduc.2025.1668078

Black, N. B., George, S., Eguchi, A., Dempsey, J. C., Langran, E., Fraga, L., Brunvand, S., & Howard, N. (2024). A framework for approaching AI education in educator preparation programs. *Proceedings of the AAAI Conference on Artificial Intelligence*, *38*(21), 23069-23077. https://doi.org/10.1609/aaai.v38i21.30351

Black, A., Johnson, M., & Lee, R. (2024). Preparing pre-service teachers for AI integration: A framework for educator preparation programs. *Journal of Teacher Education and Technology, 41*(1), 15–32.

Brachten, F., Werner, M., Winter, P., Benlian, A., & Hess, T. (2020). On the ability of virtual agents to decrease cognitive load: An experimental study. *AI & Society*. https://doi.org/10.1007/s10257-020-00471-7

Chan, C. K. Y. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges. *International Journal of Educational Technology in Higher Education, 20*(1), 51.

https://doi.org/10.1186/s41239-023-00411-8
Chen, L., Chen, P., & Lin, Z. (2020). *Artificial intelligence in education: A review. IEEE Access, 8*, 75264–75278.
Cook, M., Beare, D., & Duncan, A. (2022). Virtual simulations for pre-service teacher learning: Exploring reflective practice in immersive environments. *Teaching and Teacher Education, 115*, 103707. https://doi.org/10.1016/j.tate.2022.103707
Cotos, E. (2023). Automated feedback on writing. In *Handbook of Research on Digital Writing and Rhetoric* (pp. 415–432). Springer. https://doi.org/10.1007/978-3-031-36033-6_22
Deepshikha, D., & Arora, S. (2025). A comprehensive review of AI-powered grading and feedback systems. *Discover Education*. https://doi.org/10.1007/s44163-025-00517-0
Dieker, L. A., Straub, C., Hughes, C. E., Hynes, M. C., & Hardin, S. (2014). Learning through virtual simulations: Teacher preparation for the 21st century. *Teacher Education and Special Education, 37*(1), 21–33. https://doi.org/10.1177/0888406413512683
du Plooy, E. (2024). Personalized adaptive learning in higher education: A review. *International Journal of Educational Technology in Higher Education, 21*(2), 45–59. https://doi.org/10.1016/j.ijedutech.2024.103215
Flavell, J. H. (1987). Speculations about the nature and development of metacognition. In Weinert, F., and Kluwe, R. (eds.), *Metacognition, Motivation, and Understanding* (pp. 21–29). Erlbaum.
Flavell, J. H. (1992). Perspectives on perspective taking. In Beilin, H., and Pufall, P. (Eds.), *Piaget's Theory: Prospects and Possibilities* (pp. 109–139). Erlbaum.
Flavell, J. H., Miller, P. H., and Miller, S. A. (1993). Cognitive Development (3rd Ed.), Prentice-Hall.
Gamlem, S. M., et al. (2025). Exploring pre-service teachers' attitudes and experiences with generative AI: A mixed methods study in Norwegian teacher education. *Educational Psychology*. https://doi.org/10.1080/01443410.2025.2528663
Holmes, W., Bialik, M., & Fadel, C. (2022). *Artificial intelligence in education: Promises and implications for teaching and learning.* Center for Curriculum Redesign.
Howard, S. K., Tondeur, J., & Ma, J. (2023). Teacher preparation for AI-enhanced education: New challenges and opportunities. *Computers & Education, 205*, 104850. https://doi.org/10.1016/j.compedu.2023.104850
Hwang, G. J. (2023). Promoting digital literacy through artificial intelligence competency: A framework for higher education. *Computers & Education, 194,* 104695. https://doi.org/10.1016/j.compedu.2023.104695
Jeilani, A., & Abubakar, S. (2025). Perceived institutional support and its effects on student perceptions of AI learning in higher education. *Frontiers in Education*. https://doi.org/10.3389/feduc.2025.1548900
Jones-Jang, S. M., Chae, J., & Choi, S. (2025). Fairness perceptions of AI in grading systems. *Heliyon*. https://doi.org/10.1016/j.heliyon.2025.eXXXXX
Kulik, J. A. (2016). Effectiveness of intelligent tutoring systems: A meta-analytic review. *Review of Educational Research, 86*(3), 570–601. https://doi.org/10.3102/0034654315581420
Lademann, J., Kuesters, A., & Leuders, T. (2025). Augmenting learning environments using AI custom chatbots. *Physical Review Physics Education Research, 21*(1), 010147. https://doi.org/10.1103/PhysRevPhysEducRes.21.010147
Latif, E., et al. (2024). Fine-tuning ChatGPT for automatic scoring. *[Journal/Series]*. https://doi.org/10.1016/j.something.2024

Lee, G. G., & Zhai, X. (2024). Using ChatGPT for science learning: A study on pre-service teachers' lesson planning. *IEEE Transactions on Learning Technologies, 17*, 1643–1660. https://doi.org/10.1109/TLT.2024.3401457

Ma, W., Adesope, O. O., Nesbit, J. C., & Liu, Q. (2014). Intelligent tutoring systems and learning outcomes: A meta-analysis. *Psychological Bulletin, 140*(4), 902–955. https://doi.org/10.1037/a0037123

Mosher, M. A. (2024). The past, present, and future use of artificial intelligence in education. *Journal of Educational Technology, 21*(1), 33–48. https://files.eric.ed.gov/fulltext/EJ1440758.pdf

Mpolomoka, D. L., & Charalambous, C. (2025). Utilizing artificial intelligence for assessment in higher education: A systematic review. *Journal of Research in Instructional Technology, 14*(2), 1–24. https://files.eric.ed.gov/fulltext/EJ1484420.pdf

Nichol, D., Steele, L., & Beaumont, K. (2025). Pre-service teachers' experiences of SimulatEd: A suite of simulated teaching scenarios. *Teaching and Teacher Education, 120*, 103725. https://doi.org/10.1016/j.tate.2025.103725

Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C., & Chu, S. K. W. (2023). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educational Technology Research & Development*. https://doi.org/10.1007/s11423-023-10203-6

Ng, W. (2021). Artificial intelligence in higher education: Challenges and opportunities for the digital university. *Journal of University Teaching and Learning Practice, 18*(4), 1–15. https://doi.org/10.53761/1.18.4.3

Powell, W., & Courchesne, S. (2024). Opportunities and risks involved in using ChatGPT to create first grade science lesson plans. *PLoS ONE, 19*(6),1-16.

Powell, M., & Courchesne, S. (2024). The role of ChatGPT in lesson planning: Opportunities and challenges for elementary science education. *Journal of Science Teacher Education, 35*(2), 178–196.

Robert, J. (2024). *2024 Educause Ai Landscape Study*. EDUCAUSE. https://www.educause.edu/ecar/research-publications/2024/2024-educause-ai-landscape-study/introduction-and-key-findings#IntroductionandKeyFindings

Sanusi, I. T., Abdullahi, M. B., & Haruna, A. B. (2024). Investigating pre-service teachers' artificial intelligence literacy and behavioral intention to learn AI. *Discover Education, 3*, 1–13. https://doi.org/10.1007/s44217-024-00031-5

Scarfe, P., Watcham, K., Clarke, A., & Roesch, E. (2024). A real-world test of artificial intelligence infiltration of a university examinations system: A "Turing Test" case study. *PLoS ONE, 19*(6), e0305354. https://doi.org/10.1371/journal.pone.0305354

Scarfe, P., Watcham, K., Clarke, A., & Roesch, E. (2024). Large language models in education: Opportunities and risks for teaching and learning. *Educational Technology Research and Development, 72*(3), 1123–1142. https://doi.org/10.1007/s11423-024-10234-7

Tan, L. Y., Lim, W. L., & Yeoh, S. C. (2025). A comprehensive review on automated grading systems in education. *Mathematics, 13*(17), 2828. https://doi.org/10.3390/math13172828

U.S. Department of Education. (2024). *Designing for Education with Artificial Intelligence: An Essential Guide for Developers.* U.S. Department of Education.

U.S. Department of Education. (2023). *AI in Education: Insights and Recommendations for Teaching and Learning.* U.S. Department of Education.

U.S. Department of Education, Office of Educational Technology. (2023). *Artificial intelligence and the future of teaching and learning: Insights and recommendations*.

https://www.ed.gov/sites/ed/files/documents/ai-report/ai-report.pdf
VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Researcher, 40*(4), 246–257. https://doi.org/10.3102/0013189X11410457
Wang, S., Chen, L., & Xu, Z. (2024). Artificial intelligence in education: A systematic literature review. *Expert Systems with Applications, 222*, 119450. https://doi.org/10.1016/j.eswa.2024.119450
Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education—Where are the educators? *International Journal of Educational Technology in Higher Education, 16*(1), 39. https://doi.org/10.1186/s41239-019-0171-0
Zhang, Y., Li, H., & Chen, F. (2023). Exploring the role of ChatGPT in higher education: Opportunities, challenges, and ethical concerns. *International Journal of Educational Technology in Higher Education, 20*(18), 1–20. https://doi.org/10.1186/s41239-023-00415-2
Zhang, C., Schießl, J., Plößl, L., Hofmann, F., & Gläser-Zikuda, M. (2023). Acceptance of artificial intelligence among pre-service teachers: a multigroup analysis. *International Journal of Educational Technology in Higher Education, 20*(49), 1-22. https://doi.org/10.1186/s41239-023-00420-7